

Three Perspectives on Peer Tutoring for CS1

Sarah Loos
Indiana University
Department of Computer Science
812.855.6486

smloos@indiana.edu

Suzanne Menzel
Indiana University
Department of Computer Science
812.855.0778

menzel@indiana.edu

Melanie Poparad
Indiana University
Department of Computer Science
812.855.6486

mpoparad@indiana.edu

ABSTRACT

The pipeline of incoming computer science students has shriveled to half its size three years ago and, despite efforts to reverse the trend, the proportion of women students continues to dwindle. Computer science departments are realizing that immediate measures are needed to attract and retain undergraduate students. To address both the retention problem and the apparent disinterest for computer science among women, Indiana University established a peer-tutoring program for students in CS1 that also aims to increase the visibility and perception of undergraduate women in the department. We present the design and implementation of our program and describe our experiences, during its inaugural semester, from three perspectives: the logistics of administering the program, the point of view of a peer tutor, and the perspective of a student taking the course.

Categories and Subject Descriptors

K.4.0 [Computers and Society]: Gender and Diversity Issue

General Terms

Human Factors

Keywords

Peer tutors, Retention, Attrition, Women, Gender, Diversity.

1. INTRODUCTION

In an attempt to reduce attrition and increase the success rate of students in our CS1 course, we instituted a peer-tutoring program at Indiana University during spring 2006. The benefits of peer-tutoring for both the tutor and the tutee are well known [1, 5]. We are also interested in resuscitating the perilously low number of women students who persist in the major. According to the recent Taulbee Survey, only 15.1% of new Bachelor's degrees from Ph.D.-granting computer science departments were awarded to women in 2004-2005 [9]. The situation at Indiana University is more dire – in 2004-2005, just 3 of the 55 degrees awarded, a mere 5.9%, went to women. Inroads have been made at the graduate and faculty level. We now have one tenured woman on

our computer science faculty and four others at the assistant level, and all are active members of our Women in Computing (WIC@IU) group [8]. Not surprisingly, most of our women graduate students are international students. To increase the number of domestic women, attention must be paid to the undergraduate population. In particular, new and focused efforts to address the portion of the pipeline connecting high school to college are needed [2, 6], as are retention initiatives such as the one described here. Otherwise, the 1985 prediction that women “will be relegated to the status of second-class citizen in the world of computing” [3] will become vacuously true for US women as they reach extinction in undergraduate programs.

One often-cited reason for the deepening divide is the unflattering geek image that surrounds computer science [6] and a strongly advocated antidote is the use of mentors and role models [7]. Thus, we made a conscious decision to raise the visibility of our female students by drafting social, articulate women for the tutoring positions and, by so doing, counter the negative image of computer scientists as jargon-spouting, antisocial males.

2. CHOOSING THE TUTORS

2.1 Qualifications

We identified three high-achieving women students who had completed our CS1 course the previous semester, and invited them to participate in a pilot program to provide individualized homework help to the current group of students.

The tutoring sessions are open to all students in the class, not just the women students. Although we intentionally selected women as the tutors, we did not sacrifice quality – all three of our tutors completed CS1 at the top of their class. We looked for women who were good problem solvers, had demonstrated effective skills in working collaboratively with others, had an interest in helping others, and whom we thought could teach with compassion while adapting to different learning styles.

2.2 Women as Role Models

The desired outcome of intentional role modeling is to influence the observer's view of the goal as attainable and relevant [4].

We placed these technically competent women in a position of respect and tasked them to share their newly acquired expertise with the current students. We hoped that the CS1 women would see the tutors as role models, giving them increased confidence in their own abilities and chances for future success. Because the tutor and the tutee are not very far removed in age or experience, a natural consequence is for the tutee to imagine herself in the position of tutor the following semester, providing an attainable goal and a motivation to master the CS1 material and tackle

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subsequent computer science courses. The tutor need not do anything special to elicit this response – her mere presence is proof that women can and do succeed in this discipline. Indeed, without advertising the need for new tutors, we received more unsolicited inquiries from the women students about becoming tutors the following semester than we had positions available. Interestingly, no male students applied for the job, perhaps because WIC@IU had been billed previously as a sponsor of the tutoring sessions [8].

3. PROGRAM LOGISTICS

3.1 Staffing, Refreshments and Space

Two days before the due date of an assignment, we hold an evening help session staffed by two tutors. Refreshments (drinks, chips, fresh fruit, cookies, etc.) are provided. The space is bright, open, comfortable, with windows to the outside, and equipped with several computers, though most of the time students bring their own laptops.

3.2 Timing

The timing of the help sessions, in relation to the assignment deadline, is critical. Our sessions are held on Monday evenings. Students will have had the opportunity to work independently on the assignment over the weekend and most have made some progress, enough to have knocked off the easy problems and have identified the trouble spots. With only two days to go until the Wednesday deadline, they are giving the assignment their full attention.

3.3 Duration and Dollars

The tutors are paid \$10/hour for their efforts. They are on a rotating schedule so a given tutor works two out of every three weeks. Initially, the sessions were two hours in duration, but we later increased them to three hours in response to feedback we received from the tutors.

3.4 Expectations

Tutors are expected to have complete and detailed knowledge of the current homework assignment and should have implemented all problems themselves prior to the help sessions.

3.5 Cohort Groups

We initially thought it a good idea to assign each tutor to a small group of 2-3 women students, asking them to get together in a neutral location, such as a coffee shop, for one hour per week. The purpose of the weekly meeting was to answer any questions about the course material in a smaller, non-threatening, women-only group and also to provide friendship and information about the department culture.

The cohort groups met a few times at the beginning of the semester, but as students became busier they soon fizzled out completely. We did not make any attempt to revive them later, instead choosing to extend the hours of the homework help sessions, which benefit all students in the class.

3.6 Graduate Student Facilitator

In addition to the three undergraduate peer tutors, we hire a graduate student to help manage the program. This student is someone who has previously assisted in teaching CS1, but is currently not associated with the course. The duties of the graduate student are to organize the weekly schedule, conduct

training sessions, monitor the homework help sessions to ensure that the tutors are providing the appropriate level of assistance to the students, and to give general advice and support to the tutors.

3.6.1 Training

During the first week of the semester, we hold an orientation and scheduling session with the three tutors, the graduate student facilitator, and the course instructor(s). After introducing everyone, we explain the purpose of the peer-tutoring program and make sure that everyone understands his or her roles. We also establish the weekly schedule and emphasize the importance of being prepared and dependable. Many of the same admonishments that one gives a fresh teaching assistant also apply.

The second week, the graduate student facilitator conducts a two-hour training session for the tutors. Several approaches the tutors can use to help a student identify the source of the problem are discussed, with examples, such as:

- Ask the student to restate the problem to you.
- Ask leading questions.
- Explain a solution to a related problem.
- Simplify the problem at hand.
- Draw pictures.
- Work through a hand trace.

We also review various teaching methods and ways of interacting with students, such as:

- Whiteboard vs. notebook paper.
- Give the student time to think.
- Work with what they give you, not against it.
- Be positive and approachable.
- Give hints, not answers.

For many of these points, we provide a concrete example of actual student programs the tutors are likely to encounter and the tutors get a chance to practice reacting to the sample code.

4. THREE PERSPECTIVES

In this section we give three perspectives on the peer-tutoring program, based on our personal experiences.

4.1 The Tutor Perspective

As the third author of this paper, I am one of the original peer tutors. I have had other tutoring experiences, specifically in the field of mathematics, but my computer science tutoring experience has benefited me the most in my personal life, as well as my own education and understanding.

One of the many rewards of this tutoring program was the relationships I developed with my co-tutors, who were also students in my own classes. The semester before the three of us became tutors, we were in the same CS1 lecture together. Ironically, we did not interact or converse until our tutoring orientation. Being the only women in the class, it was extremely difficult to become friends. The tutoring program brought us together, as I believe it has also brought the women attending the tutoring sessions together. In addition to friendships, this contact also created a much-needed support system. It is isolating to be a woman in this field and, by sticking together, it seems to make things a bit easier. This experience has created lasting friendships for me with other women who share my academic interests.

Another positive aspect involves the issue of respect. Some men in computer science seem to believe that they are “better” in this

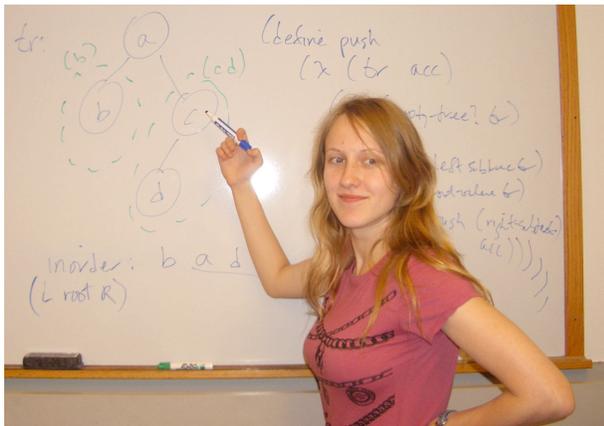


Figure 1: Acacia Davis, one of our peer tutors, explains how to traverse a binary tree in inorder.

field than the women in their classes. They seem to have less respect for women and question their abilities. Through my experience with this tutoring program, I was able to help men obtain a better understanding of the material and concepts, and also dispel the notion that computers are “for boys only”. I remember one specific night, after our weekly tutoring session, feeling as if my efforts had actually changed some of the male students’ preconceived notions of women in science. I went home feeling I had earned their respect.

Additionally, as I helped students understand their problems, I had to restructure the information in my own mind so I could convey the concepts to others. This solidified my understanding of the material, has made me a better programmer and has given me greater confidence that I’ll succeed in my future classes.

4.2 The Tutee Perspective

This is written from the perspective of the first author, a student who attended the peer tutoring sessions during spring 2006. The first time I went to a tutoring session, I did not need help with a specific problem, but was lured instead by the offer of free food. When I arrived at the session, I discovered a wealth of information and resources in the tutors, not only for the homework material, but also concerning other classes in the computer science department and about degree requirements.

As the year progressed and the difficulty of the assignments increased, I continued to attend the sessions for help with the programming, and I began to develop relationships with the tutors. I was enjoying the course material so much that I began asking the tutors about the degree requirements for a computer science minor. Not only did they tell me what courses I would need to take, they also said they were confident in my ability to complete the required coursework. Largely because of their encouraging comments, I declared a computer science minor that semester, even though I was only halfway through my first college computer science class.

Toward the end of the semester, I consulted with the tutors about which classes I should register for in the coming semester. They gave me advice about which courses were most challenging and whether I should take the honors version of certain classes. Also,

we were able to speak candidly about the teaching styles of various professors, a liberty that the CS1 professor is not afforded.

As the final exam drew near, the coursework increased in difficulty and intensity. The programs were more complex and my bugs became more elusive and resistant to my efforts to fix them. After working on an assignment for several days, it was helpful to go to the peer tutoring sessions and have someone else review my code. When I would get stuck on particular problems, I was often able to solve them with ease after a minor hint from one of the tutors.

At the end of the course, I approached my instructor about being a tutor for the next semester and was delighted when I was accepted. Perhaps now that I am a tutor, I will be able to help and encourage some of the students currently in CS1 just as my tutors inspired me.



Figure 2: Sarah Loos helping a student understand prefix notation

4.3 The Instructor Perspective

The second author has been an instructor for CS1 at Indiana University for many years, including last spring, last summer and the current semester. I have noticed an increase in the collaborative atmosphere in the course. The students seem to have a more positive attitude towards the subject matter; they are more cooperative and engaged, less competitive, and better understand the benefits of helping each other learn the material rather than just providing answers.

4.3.1 Recursion as an Early Challenge

Our CS1 course uses the Scheme programming language. There is a weekly programming assignment that consists of ten to fifteen problems of varying degrees of difficulty. Recursion on lists is introduced in the third week of the course and represents a significant, but not insurmountable, obstacle for many students.

4.3.2 A Peer Relationship is a Balanced Relationship

The tutoring sessions help the students grasp the nature of recursion in a new way. The peer nature of the interaction and the fact that the tutors have no grading responsibilities means the discourse is more balanced than between student and professor. The tutor and tutee have a similar status and speak a similar language. The tutees are more comfortable expressing opinions, more honest about their level of understanding, and more willing to take risks in proposing problem solving strategies.

4.3.3 Costs

The peer-tutoring program is low-cost and easy to administer. Our total budget for the fall semester is approximately \$1,200, quite a bit less than the nearly \$2,000 that is paid to a single Undergraduate Assistant. This year we have staff support to shop for the refreshments, set them out and clean up.

4.3.4 Impact

I was the sole instructor for CS1 during spring 2005 and spring 2006. The attrition rate dipped 11% with a marginal increase in GPA grades. The only major difference between these iterations of the course was the institution of the peer-tutoring program. While not a startling change, it is encouraging and merits further study.

This semester, fall 2006, 14 of the 100 students enrolled in CS1 are women. Our typical percentages hover between 6 and 9%. The increase may be due to more aggressive recruiting efforts or it may just be happenstance. Regardless, these 14 women represent a resource we do not intend to squander. Although it is too early to judge the long-term effect of the peer-tutoring program, it certainly does not hurt, is low-cost, low-risk and worth doing.

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